CHOICE BASED CREDIT SYSTEM - LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK	
Programme	**M.Sc.**
Programme Code	22
Duration	**2 years for PG**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society**

	To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

CHOICE BASED CREDIT SYSTEM - LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK

M.Sc Chemistry

Part		Course	Code	Cr.	Hrs
SEMESTER I					
A	CC – 1	Organic Reaction Mechanism – I	232204101	4	5
	CC – 2	Structure and Bonding in Inorganic Compounds	232204102	4	5
	CC – 3	Organic Chemistry Practical	232204103	4	5
	EC –I (Generic/ DS)	Pharmaceutical Chemistry	232204104	3	5
		Nano Materials and Nano Technology	232204105		
	Elective - II	Electro Chemistry	232204106	3	5
		Molecular Spectroscopy	232204107		
B	SEC I	Preparation of Consumer products Lab	232204108	2	3
	AECC - 1	Chemistry in Consumer Products	232204109	2	2
	Total			**22**	**30**
SEMESTER II					
A	CC – 4	Organic Reaction Mechanism II	232204201	4	5
	CC – 5	Physical Chemistry – I	232204202	4	5
	CC – 6	Inorganic Chemistry Practicals	232204203	4	5
	EC – III	Medicinal Chemistry	232204204	3	5
		Green Chemistry	232204205		
	EC - IV	Bio Inorganic Chemistry	232204206	3	5
		Material Science	232204207		
B	SEC – II	Drugs and Cosmetics	232204208	2	3
	AECC - 2	Food Preservation	232204209	2	2
				22	**30**
SEMESTER III					
A	CC – 7	Organic Synthesis and Photochemistry	232204301	4	5
	CC – 8	Coordination Chemistry – I	232204302	4	5
	CC – 9	Physical Chemistry Practical	232204303	4	5
	EC - V	Pharmacognosy and Phytochemistry	232204304	3	5
		Biomolecules and Heterocyclic Compounds	232204305		
	Core	Industrial Chemistry	232204306	3	4
B	SEC – III	Molecular spectroscopy	232204307	2	4
	AECC – 3	Research Tools and Techniques in Chemistry	232204308	2	2
	Internship	**Internship / Industrial Activity**	232204309	2	-
				24	**30**
SEMESTER IV					
A	CC – 10	Coordination Chemistry - II	232204401	4	5
	CC – 11	Physical Chemistry – II	232204402	4	5
	CC - 12	Analytical Instrumentation Technique Practicals	232204403	4	5
	CC – 13	Project with Viva Voce	232204404	3	4
	EC VI	Polymer Chemistry	232204405	3	5
		Cheminformatics	232204406		
B	SEC IV	Chemistry of Natural products and Organic spectroscopy	232204407	2	4
	AECC – 4	Interpretation and Identification of Chemical Compounds	232204408	2	2
C	EA	Extension Activity	**232204409**	1	

	Total			**23**	**30**
* Internship will be carried out during the summer vacation of the first year and marks will be included in the Third Semester Marks Statement.					

Title of the Course		**ORGANIC SYNTHESIS AND PHOTOCHEMISTRY**						
Category	Core - 7	**Year**	II	**Credits**	4	**Course Code**	**232204301**	
		Semester	III					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		4	1	--	5	25	75	100

Learning Objectives

- ✍ To understand the molecular complexity of carbon skeletons and the presence of functional groups and their relative positions.
- ✍ To study various synthetically important reagents for any successful organic synthesis.
- ✍ To apply disconnection approach and identifying suitable synthons to effect successful organic synthesis.
- ✍ To learn the concepts of pericyclic reaction mechanisms.
- ✍ To gain the knowledge of photochemical organic reactions

UNIT	Details	No. of Periods for the Unit
I	Planning an Organic Synthesis and Control elements: Preliminary Planning – knowns and unknowns of the synthetic system studied, analysis of the complex and interrelated carbon framework into simple rational precursors, retrosynthetic analysis, alternate synthetic routes, key intermediates that would be formed, available starting materials and resulting yield of alternative methods. Linear Vs convergent synthesis. synthesis based on umpolung concepts of Seeback, regiospecific control elements. Use of protective groups, activating groups and bridging elements. Examples on retrosynthetic approach, calculation of yield, advantages of connvergent synthesis, synthesis of stereochemistry-controlled products.	**15**
II	**Organic Synthetic Methodology:** Retrosynthetic analysis; Alternate synthetic routes. Synthesis of organic mono and bifunctional compounds via disconnection approach. Key intermediates, available starting materials and resulting yields of alternative methods. Convergent and divergent synthesis, Synthesis based on umpolung concepts of Seebach. Protection of hydroxyl, carboxyl, carbonyl, thiol and amino groups. Illustration of protection and deprotection in synthesis. Control elements: Regiospecific control elements. Use of protective groups, activating groups, and bridging elements. Stereospecific control elements. Functional group alterations and transposition.	**15**
III	**Pericyclic Reactions:** Woodward Hoffmann rules; The Mobius and Huckel concept, FMO, PMO method and correlation diagrams. Cycloaddition and retrocycloaddition reactions; [2+2], [2+4], [4+4, Cationic, anionic, and 1,3-dipolar cycloadditions. Cheletropic reactions. ; Electrocyclization and ring opening reactions of conjugated dienes and trienes. Sigmatropic rearrangements: (1,3), (1,5), (3,3) and (5,5)-carbon migrations, degenerate rearrangements. Ionic sigmatropic rearrangements. Group transfer reactions. Regioselectivity, stereoselectivity and periselectivity in pericyclic reactions.	**15**

IV	**Organic Photochemistry-I:** Photochemical excitation: Experimental techniques; electronic transitions; Jablonskii diagrams; intersystem crossings; energy transfer processes; Stern Volmer equation. Reactions of electronically excited ketones; $\pi \rightarrow \pi^*$ triplets; Norrish type-I and type-II cleavage reactions; photo reductions; Paterno-Buchi reactions;	**15**
V	**Organic Photochemistry-I:** Photochemistry of α,β-unsaturated ketones; cis-trans isomerisation. Photon energy transfer reactions, Photo cycloadditions, Photochemistry of aromatic compounds; photochemical rearrangements; photo-stationery state; di-π-methane rearrangement; Reaction of conjugated cyclohexadienone to 3,4-diphenyl phenols; Barton's reactions.	**15**

Course Outcomes	
Course Outcomes	On completion of this course, students will;
CO1	To recall the basic principles of organic chemistry and to understand the various reactions of organic compounds with reaction mechanisms.
CO2	To understand the versatility of various special reagents and to correlate their reactivity with various reaction conditions.
CO3	To implement the synthetic strategies in the preparation of various organic compounds.
CO4	To predict the suitability of reaction conditions in the preparation of tailor-made organic compounds
CO5	To design and synthesize novel organic compounds with the methodologies learnt during the course

Text Books (Latest Editions)

1. F. A. Carey and Sundberg, Advanced Organic Chemistry, 5thed, Tata McGraw-Hill, New York, 2003.
2. J. March and M. Smith, Advanced Organic Chemistry, 5th ed., John-Wiley and sons, 2007.
3. R. E. Ireland, Organic synthesis, Prentice Hall India, Goel publishing house, 1990.
4. Clayden, Greeves, Warren, Organic Chemistry, Oxford University Press, Second Edition, 2016.
5. M. B. Smith, Organic Synthesis 3rd edn, McGraw Hill International Edition, 2011.

References Books

(Latest editions, and the style as given below must be strictly adhered to)

1. Gill and Wills, Pericyclic Reactions, Chapman Hall, London, 1974.
2. J.A. Joule, G.F. Smith, Heterocyclic Chemistry, Garden City Press, Great Britain, 2004.
3. W. Caruthers, Some Modern Methods of Organic Synthesis 4thedn, Cambridge University Press, Cambridge, 2007.
4. H. O. House. Modern Synthetic reactions, W.A. Benjamin Inc, 1972.
5. Jagdamba Singh and Jaya Singh, Photochemistry and Pericyclic Reactions, New Age International Publishers, New Delhi, 2012.

Web Resources

1.https://rushim.ru/books/praktikum/Monson.pdf

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		**COORDINATION CHEMISTRY – I**						
Category	Core – 8	**Year**	II	**Credits**	4	**Course Code**	**232204302**	
		Semester	III					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		4	1	--	5	25	75	100

Learning Objectives

- To gain insights into the modern theories of bonding in coordination compounds.
- To learn various methods to determine the stability constants of complexes.
- To understand and construct correlation diagrams and predict the electronic transitions that are taking place in the complexes.
- To describe various substitution and electron transfer mechanistic pathways of reactions in complexes.
- To evaluate the reactions of octahedral and square planar complexes.

UNIT	Details	No. of Periods for the Unit
I	**Modern theories of coordination compounds:** Crystal field theory - splitting of d orbitals in octahedral, tetrahedral and square planar symmetries - measurement of 10Dq - factors affecting 10Dq - spectrochemical series - crystal field stabilisation energy for high spin and low spin complexes- evidences for crystal field splitting - site selections in spinels and antispinels - Jahn Teller distortions and its consequences. Molecular Orbital Theory and energy level diagrams concept of Weak and strong fields, Sigma and pi bonding in octahedral, square planar and tetrahedral complexes.	**15**
II	**Spectral characteristics of complexes:** Term states for d ions - characteristics of d-d transitions - charge transfer spectra - selection rules for electronic spectra - Orgel correlation diagrams - Sugano-Tanabe energy level diagrams - nephelauxetic series - Racha parameter and calculation of inter-electronic repulsion parameter.	**15**
III	**Stability and Magnetic property of the complexes:** Stability of complexes: Factors affecting stability of complexes, Thermodynamic aspects of complex formation, Stepwise and overall formation constants, Stability correlations, statistical factors and chelate effect, Determination of stability constant and composition of the complexes: Formation curves and Bjerrum's half method, Potentiometric method, Spectrophotometric method, Ion exchange method, Polorographic method and Continuous variation method (Job's method) Magnetic property of complexes: Spin-orbit coupling, effect of spin-orbit coupling on magnetic moments, quenching of orbital magnetic moments.	**15**
IV	**Kinetics and mechanisms of substitution reactions of octahedral and square planar complexes:** Inert and Labile complexes; Associative, Dissociative and SNCB mechanistic pathways for substitution reactions; acid and base hydrolysis of octahedral complexes; Classification of metal ions based on the rate of water replacement reaction and their correlation to Crystal Field Activation Energy; Substitution reactions in square planar complexes: Trans effect, theories of trans effect and applications of trans effect in synthesis of square planar compounds; Kurnakov test	**15**
V	Electron Transfer reactions in octahedral complexes: Outer sphere electron transfer reactions and Marcus-Hush theory; inner sphere electron transfer reactions; nature of the bridging ligand in inner sphere electron transfer reactions. Photo-redox, photo-substitution and photo-isomerisation reactions in complexes and their applications	**15**

Course Outcomes	
Course Outcomes	On completion of this course, Students will be able
CO1	Understand and comprehend various theories of coordination compounds.
CO2	Understand the spectroscopic and magnetic properties of coordination complexes.
CO3	Explain the stability of complexes and various experimental methods to determine the stability of complexes.
CO4	Predict the electronic transitions in a complex based on correlation diagrams and UV-visible spectral details.
CO5	Comprehend the kinetics and mechanism of substitution reactions in octahedral and square planar complexes.

Text Books (Latest Editions)	
1	J E Huheey, EA Keiter, RL Keiter and OK Medhi, Inorganic Chemistry – Principles of structure and reactivity, 4th Edition, Pearson Education Inc., 2006.
2	G L Meissler and D ATarr, Inorganic Chemistry, 3rd Edition, Pearson Education Inc., 2008
3	D. Bannerjea, Co-ordination Chemistry, TATA Mcgraw Hill, 1993.
4	B. N. Figgis, Introduction to Ligand Fields, Wiley Eastern Ltd, 1976.
5	F. A. Cotton, G. Wilkinson.; C. A. Murillo; M. Bochmann, Advanced Inorganic Chemistry, 6th ed.; Wiley Inter-science: New York, 1988.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Keith F. Purcell and John C. Kotz, Inorganic Chemistry, Saunders Publications, USA, 1977.
2	Peter Atkins and Tina Overton, Shriver and Atkins' Inorganic Chemistry, 5th Edition, Oxford University Press, 2010.
3	Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson, P. L. Guas, John Wiley, 2002, 3rd edn.
4	Concepts and Models of Inorganic Chemistry, B. Douglas, D. McDaniel, J. Alexander, John Wiley, 1994, 3rd edn.
5	Inorganic Chemistry, D. F. Shriver, P. W. Atkins, W. H. Freeman and Co, London, 2010.
Web Resources	
01.https://ocw.mit.edu/courses/5-04-principles-of-inorganic-chemistry-ii-fall-2008/pages/syllabus/	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		**PHYSICAL CHEMISTRY PRACTICAL**						
Category	Core - 9	**Year**	II	**Credits**	4	**Course Code**	**232204303**	
		Semester	III					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		-	-	5	5	25	75	100

Learning Objectives

- ✍ To understand the principle of conductivity experiments through conductometric titrations.
- ✍ To evaluate the order of the reaction, temperature coefficient, and activation energy of the reaction by following pseudo first order kinetics.
- ✍ To construct the phase diagram of two component system forming congruent melting solid and find its eutectic temperatures and compositions.
- ✍ To determine the kinetics of adsorption of oxalic acid on charcoal.
- ✍ To develop the potential energy diagram of hydrogen ion, charge density distribution and Maxwell's speed distribution by computational calculation.

Experiments

Conductivity Experiments

1.Determination of equivalent conductance of a strong electrolyte & the verification of DHO equation.

2. Verification of Ostwald's Dilution Law & Determination of pKa of a weak acid.

3. Verification of Kohlrausch's Law for weak electrolytes.

4. Determination of solubility of a sparingly soluble salt.

5. Acid-base titration (strong acid and weak acid vs NaOH).

6. Precipitation titrations (mixture of halides only).

Kinetics

1. Study the kinetics of acid hydrolysis of an ester, determine the temperature coefficient and also the activation energy of the reaction.
2. Study the kinetics of the reaction between acetone and iodine in acidic medium by half-life method and determine the order with respect to iodine and acetone.

Phase diagram

Construction of phase diagram for a simple binary system

1. Naphthalene-phenanthrene
2. Benzophenone- diphenyl amine

Adsorption

Adsorption of oxalic acid on charcoal & determination of surface area (Freundlich isotherm only).

Course Outcomes

Course Outcomes	On completion of this course, students will;
CO1	To recall the principles associated with various physical chemistry experiments.
CO2	To scientifically plan and perform all the experiments.
CO3	To observe and record systematically the readings in all the experiments.
CO4	To calculate and process the experimentally measured values and compare with graphical data.
CO5	To interpret the experimental data scientifically to improve students' efficiency for societal developments.

Text Books (Latest Editions)	
1.	B. Viswanathan and P.S.Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009.
2.	Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996.
3.	V.D. Athawale and Parul Mathur, Experimental Physical Chemistry, New Age International (P) Ltd., New Delhi, 2008.
4.	E.G. Lewers, Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, 2nd Ed., Springer, New York, 2011.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1	J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
2	G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009.
3	J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.
4	Shailendra K Sinha, Physical Chemistry: A laboratory Manual, Narosa Publishing House Pvt, Ltd., New Delhi, 2014.
5	F. Jensen, Introduction to Computational Chemistry, 3rd Ed., Wiley-Blackwell.
Web Resources	
1	https://web.iitd.ac.in/~nkurur/201516/Isem/cmp511/lab_handout_new.pdf

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		**PHARMOCOGNOSY AND PHYTOCHEMISTRY**						
Category	EC – 5.1	**Year**	II	**Credits**	3	**Course Code**	**232204304**	
		Semester	III					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		5	-	--	5	25	75	100

Learning Objectives

- ✍ To develop the knowledge of natural products, biological functions and pharmacological uses.
- ✍ To develop knowledge on primary and secondary metabolites and their sources
- ✍ To understand the concepts of isolation methods and separation of bioactive compounds.
- ✍ To provide the knowledge on selected glycosides and marine drugs.
- ✍ To familiarize the guidelines of WHO and different sampling techniques

UNIT	**Details**	**No. of Periods for the Unit**
I	**Pharmacognosy and Standardization of Herbal drugs:** Introduction, definition, development classification and Source of Drugs: Biological, mineral, marine,and plant tissue cultures. Study of pharmacognostic of a crude drug. Biosynthesis: Shikimic acid pathway and acetate pathway. Systematic analysis of Crude drugs. Standardization of Herbal drugs. WHO guidelines, Sampling of crude drug, Methods of drug evaluation. Determination of foreign matter, moisture Ash value. Phytochemical investigations-General chemical tests.	**15**
II	**Extraction Techniques:** General methods of extraction, types – maceration, Decoction, percolation, Immersion and soxhlet extraction. Advanced techniques - counter current, steam distillation, supercritical gases, sonication, Micro waves assisted extraction. Factors affecting the choice of extraction process.	**15**
III	**Drugs containing Terpenoids and volatile oils:** Terpenoids: Classification, Isoprene rule, Isolation and separation techniques, General properties Camphor, Menthol, Eucalyptol. Volatile Oils or Essential Oils: Method of Preparations, Classifications of Volatile oils, Camphor oil, Geranium oil, Citral- Structure uses. Pentacyclic triterpenoids: amyrines; taraxasterol: Structure and pharmacological applications.	**15**
IV	**Drugs containing alkaloids:** Occurrence, function of alkaloids in plants, pharmaceutical applications. Isolation, Preliminary Qualitative tests and general properties. General methods of structural elucidation. Morphine, Reserpine, papaverine - chemical properties, structure and uses. papaverine - structure, chemical properties and uses.	**15**
V	**Plant Glycosides and Marine drugs:** Glycosides: Basic ring system, classification, isolation, properties, qualitative analysis. Pharmacological activity of Senna glycosides, Cardiac glycosides-Digoxin, digitoxin, Steroidal saponins glycosides- Diosgenin, hecogenin. Plant pigments: Occurrence and general methods of structure determination, isolation and synthesis of quercetin and cyanidin chloride. Marine drugs -Selected Drug Molecules: Cardiovascular active substances, Cytotoxic compounds, antimicrobial compounds, antibiotic compounds, Anti-inflammatory agents. Marine toxins.	**15**

Course Outcomes	
Course Outcomes	On completion of this course, students will be able
CO1	To recall the sources of natural medicines and analysis of crude drugs.
CO2	To understand the methods of evaluation based on various parameters.
CO3	To analyze the isolated drugs
CO4	To apply various techniques to discover new alternative medicines.
CO5	To evaluate the isolated drugs for various pharmacological activities
Text Books (Latest Editions)	
1	Gurdeep R Chatwal (2016), Organic chemistry of Natural products, Volume I&II, 5th edition, Himalaya publishing House.
2	S.V.Bhat, B.A. Nagasampagi, M.Sivakumar (2014), Chemistry of Natural Products, Revised edition, Narosa Publishers.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Jeffrey B. Harborne (2012), Phytochemical methods: A Guide to Modern Techniques of Plant Analysis, 4th edition, Indian reprint, Springer.
2	Ashutoshkar (2007), Pharmacognosy and Pharmacobiotechnology, 2 nd edition, New age international (P) limited, New Delhi.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		**5.2 BIOMOLECULES AND HETEROCYCLIC COMPOUNDS**						
Category	EC – 5.2	**Year**	II	**Credits**	3	**Course Code**	**232204305**	
		Semester	III					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		5	-	--	5	25	75	100

Learning Objectives

- ✍ To learn the basic concepts and biological importance of biomolecules and natural products.
- ✍ To explain various of functions of carbohydrates, proteins, nucleic acids, steroids and hormones.
- ✍ To understand the functions of alkaloids and terpenoids.
- ✍ To elucidate the structure determination of biomolecules and natural products.
- ✍ To extract and construct the structure of new alkaloids and terpenoids from different methods.

UNIT	**Details**	**No. of Periods for the Unit**
I	**Chemistry and metabolism of carbohydrates:** Definition, classification and biological role of carbohydrates. onosaccharides: Linear and ring structures (Haworth formula) of ribose, glucose, fructose and mannose (structure determination not required), physical and chemical properties of glucose and fructose. Disaccharides: Ring structures (Haworth formula) – occurrence, physical and chemical properties of maltose, lactose and sucrose. Polysaccharides: Starch, glycogen and cellulose – structure and properties, glycolysis of carbohydrates.	**15**
II	**Steroids and Hormones:** Steroids-Introduction, occurrence, nomenclature, configuration of substituents. Diels' hydrocarbon, stereochemistry, classification, Diels' hydrocarbon, biological importance, colour reactions of sterols, cholesterol-occurrence, tests, physiological activity, biosynthesis of cholesterol from squalene. Hormones-Introduction, classification, functions of sex hormones- androgens and estrogens, adrenocortical hormones-cortisone and cortisol structure and functions of non-steroidal hormones-adrenaline and thyroxin.	**15**
III	**Proteins:** Separation and purification of proteins – dialysis, gel filtration and electrophoresis. Catabolism of amino acids - transamination, oxidative deamination and decarboxylation. Biosynthesis of proteins.	**15**
IV	**Nucleic acids:** Role of nucleic acids. Amino acid metabolism and urea cycle. Structure, methods for the synthesis of nucleosides - direct combination, formation of heterocyclic base and nucleoside modification, conversion of nucleoside to nucleotides. Primary and secondary structure of RNA and DNA, Watson-Crick model, solid phase synthesis ofoligonucleotides.	**15**
V	**Fused Ring Heterocyclic Compounds:** Benzofused five membered rings: Indole, isoindole, benzofuran and benzothiophene, Preparation and properties. Benzofused six membered rings: Quinoline and isoquinoline: Preparation by ring closure reactions, Reactions: Mechanism of electrophilic and nucleophilic substitutions, oxidation and reduction reactions.	**15**

Course Outcomes

Course Outcomes	On completion of this course, students will be able
CO1	To understand the basic concepts of biomolecules and natural products.

CO2	To integrate and assess the different methods of preparation of structurally different biomolecules and natural products.
CO3	To illustrate the applications of biomolecules and their functions in the metabolism of living organisms.
CO4	To analyse and rationalise the structure and synthesis of heterocyclic compounds.
CO5	To develop the structure of biologically important heterocyclic compounds by different methods.

Text Books (Latest Editions)	
1	T. K Lindhorst, Essentials of Carbohydrate Chemistry and Biochemistry, Wiley VCH, North America,2007.
2	I. L. Finar, Organic Chemistry Vol-2, 5th edition, Pearson Education Asia, 1975.
3	V. K. Ahluwalia and M. Goyal, Textbook of Heterocyclic compounds, Narosa Publishing, New Delhi,2000.
4	M. K. Jain and S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Co., Jalandhar, Delhi, 2014.
5	V. K. Ahluwalia, Steroids and Hormones, Ane books pub., New Delhi,2009.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1	I. L. Finar, Organic Chemistry Vol-1, 6thedition, Pearson Education Asia,2004.
2	Pelletier, Chemistry of Alkaloids, Van Nostrand Reinhold Co, 2000.
3	Shoppe, Chemistry of the steroids, Butterworthes,1994.
4	I. A. Khan, and A. Khanum. Role of Biotechnology in medicinal & aromatic plants, Vol 1 and Vol 10, Ukkaz Publications, Hyderabad,2004.
5	M. P. Singh. and H. Panda, Medicinal Herbs with their formulations, Daya Publishing House, Delhi,2005.
Web Resources	
https://www.organic-chemistry.org/ https://www.studyorgo.com/summary.php https://www.clutchprep.com/organic-chemistry	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		**INDUSTRIAL CHEMISTRY**						
Category	Core Industry Module	**Year**	II	**Credits**	3	**Course Code**	**232204306**	
		Semester	III					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		4	--	--	4	25	75	100

Learning Objectives

- To gain the knowledge in solid, liquid and gaseous fuel as a resource for energy production and chemical production.
- To develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.
- To learn how to prepare industrial products such as sugar, fermented and explosive products in the chemical laboratory.
- To know the information about cement, chemical constituent and composition, polymers and their uses in various engineering operations.
- To learn about the industrial materials,especially fertilizer materials for agricultural production.

UNIT	Details	No. of Periods for the Unit
I	**Industrial fuels** Classification of fuels: solid, liquid and gas. Calorific value of fuels and its determination. Solid fuels: Coal- types – properties and uses – lignite, sub-bituminous coal, bituminous coal and anthracite, Coking and non-coking coal. Liquid fuels: Refining of crude petroleum and uses of fractions, Hydrodesulphurisation. Gaseous fuels -Natural gas and gobar gas-production, composition and uses, Gobar electric cell.	**12**
II	**Water treatment** Introduction Sources of water: Hardness of water-temporary hardness, permanent hardness. Disadvantages of hard water in domestic, industry and steam generation (boilers). Estimation of hardness by EDTA method. Water softening methods: Lime – soda process, Zeolite process, Ion-exchange, Demineralisation - deionisation process. Removal of microorganism – Chlorination, Reverse osmosis, Desalination.	**12**
III	**Industries** Sugar Industry: Manufacture of sugar from molasses and beetroot – sugar industries in India. Fermentation: Manufacture of spirits and wines. Match industries: Manufacture – chemistry of lighting and pyrotechnics. Explosives: Definition – Classification – Characteristics of explosives – Nitro cellulose, T.N.T. Picric acid, Gun Powder, Cordite and Dynamite.	**12**
IV	**Polymerization:** Polymerization: Types of Polymerization–Addition and Condensation Polymerizations. Plastics –Thermosetting and Thermoplastics–composition and uses of the following: Polyethylene, PVC, Teflon, Bakelite, Polyester, Rubber–Natural and synthetic Rubber. Cement: Chemical Constituents and Composition of Cement–Setting and Hardening. Corrosion: Types of corrosion (dry, wet).	**12**

V	**Fertilizers** Fertilizers: Plant nutrients–macro & micronutrients–Need for fertilizers–Fertilizers type–Essential requirements–Classification of fertilizers–simple and mixed fertilizers–Sources–Natural and Artificial fertilizers–Nitrogenous fertilizers–Ammonium nitrate, Ammonium sulphate, Urea (Method of preparation and uses). Phosphate fertilizers–Super phosphate and triple super phosphate–Method of preparation & uses. Potash fertilizers: KNO3 : method of preparation and uses. Mixed fertilizers–preparation & uses. NPK ratio and its importance.	**12**

Course Outcomes	
Course Outcomes	On completion of this course, students will be able
CO1	To gain the knowledge about various types fuels (solid, liquid and gaseous) like coal, petrol, natural gas etc., their properties, refinement and uses.
CO2	To gain the knowledge about hardness of water estimation and removal by EDTA and softening methods used in industry.
CO3	To know about sugar, manufacture of sprits, composition and properties of different types of explosives.
CO4	To acquire knowledge of polymers, cement and corrosion in chemical industry.
CO5	To know about the manufacturing, properties and application of Nitrogen, phosphorous and potash fertilizer.

Text Books (Latest Editions)

1. B.K.Sharma, Krishnaprakasam (2014), Industrial Chemistry Including Chemical Engineering, Media,Meerut
2. A. Heaton, An Introduction to Industrial Chemistry, Springer, 2019.
3. B.N.Charabarthy – ―Industrial Chemistry‖, 1st Ed., Oxford and IBh Publishing. NewDelhi.
4. D. A. Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering,ASMEPress.
5. Norris shreve, r. And joseph a. Brink, jr. Chemical process industries, 4th ed.; Mc graw – hill Kogakusha, ltd:1977.

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1. B.K. Sharma, Industrial Chemistry, 15th edition, Goel Publishing House, 2006.
2. P.C. Jain & Monica Jain, Engineering Chemistry, Dhanpat, Rai Publications, 2009. 3. B.R. Puri, L.R. Sharma, M.S. Pathania, Principles of Inorganic Chemistry, Vishal Publishing Co., 2017.
3. A. Heaton, An Introduction to Industrial Chemistry, Chapman & Hall Pub. Co., 1996.
4. P.L. Soni, A Text Book of Inorganic Chemistry, Sultan Chand, 2013.
5. S. Mohan, V. Arjunan and Sujin P. Jose, Principles of Materials Science, MJP Publishers, Chennai, 2018.

Web Resources

1. https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004132159500424ranvijay_engg_Fuels.pdf
2. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCY1213.pdf
3. https://edurev.in/t/98513/Introduction-to-Sugar--Fermentation-Industry-and-M
4. https://unacademy.com/content/wp content/ uploads/ sites/2/ 2022/10/33.-Polymer-Notes.pdf
5. https://www.agricorn.in/2023/03/bsc-ag-chemical-fertilizers.html

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		**MOLECULAR SPECTROSCOPY**						
		Professional Communication Skill						
Category	SEC - III	**Year**	II	**Credits**	2	**Course Code**	**232204307**	
		Semester	III					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		4	--	--	4	25	75	100

Learning Objectives

- ✍ To understand the influence of rotation and vibrations on the spectra of the polyatomic molecules.
- ✍ To study the principle of Raman spectroscopy, ESR spectroscopy, EPR spectroscopy and fragmentation patterns in Mass spectroscopy.
- ✍ To highlight the significance of Franck-Condon principle to interpret the selection rule, intensity and types of electronic transitions.
- ✍ To interpret the first and second order NMR spectra in terms of splitting and coupling patterns using correlation techniques such as COSY, HETCOR, NOESY.
- ✍ To carry out the structural elucidation of molecules using different spectral techniques.

UNIT	**Details**	**No. of Periods for the Unit**
I	**Rotational and Raman Spectroscopy:** Rotational spectra of diatomic and polyatomic molecules. Intensities of rotational spectral lines, effect of isotopic substitution. Non-rigid rotators. Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, quantum theory of the Raman effect, Pure rotational Raman spectra of linear and asymmetric top molecules, Stokes and anti-Stokes lines. Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion, rotational fine structure-O and S branches, Polarization of Raman scattered photons.	**12**
II	**Vibrational Spectroscopy:** Vibrations of molecules, harmonic and anharmonic oscillators- vibrational energy expression, energy level diagram, vibrational wave functions and their symmetry, selection rules, expression for the energies of spectral lines, computation of intensities, hot bands, effect of isotopic substitution. Diatomic vibrating rotor, vibrational-rotational spectra of diatomic molecules, P, R branches, breakdown of the Born-Oppenheimer approximation. Vibrations of polyatomic molecules – symmetry properties, overtone and combination frequencies. Influence of rotation on vibrational spectra of polyatomic molecule, P, Q, R branches, parallel and perpendicular vibrations of linear and symmetric top molecules.	**12**
III	**Electronic spectroscopy:** Electronic Spectroscopy: Electronic spectroscopy of diatomic molecules, Frank-Condon principle, dissociation and predissociation spectra. $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions and their selection rules. Photoelectron Spectroscopy: Basic principles, photoelectron spectra of simple molecules, Xray photoelectron spectroscopy (XPS). Lasers: Laser action, population inversion, properties of laser radiation, examples of simple laser systems.	**12**

IV	**NMR and ESR spectroscopy:** Chemical shift, Factors influencing chemical shifts: electronegativity and electrostatic effects; Mechanism of shielding and deshielding. Spin systems: First order and second order coupling of AB systems, Simplification of complex spectra. Spin-spin interactions: Homonuclear coupling interactions - AX, AX2, AB types. Vicinal, germinal and long-range coupling-spin decoupling. Nuclear Overhauser effect (NOE), Factors influencing coupling constants and Relative intensities. 13CNMR and structural correlations, Satellites. Brief introduction to 2D NMR – COSY, NOESY. Introduction to 31P, 19F NMR. ESR spectroscopy Characteristic features of ESR spectra, line shapes and line widths; ESR spectrometer. The g value and the hyperfine coupling parameter (A), origin of hyperfine interaction. Interpretation of ESR spectra and structure elucidation of organic radicals using ESR spectroscopy; Spin orbit coupling and significance of g- tensors, zero/non-zero field splitting, Kramer's degeneracy, application to transition metal complexes (having one to five unpaired electrons) including biological molecules and inorganic free radicals. ESR spectra of magnetically dilute samples.	**12**
V	**Mass Spectrometry, EPR and Mossbauer Spectroscopy:** Ionization techniques- Electron ionization (EI), chemical ionization (CI), desorption ionization (FAB/MALDI), electrospray ionization (ESI), isotope abundance, molecular ion, fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation, high resolution. Effect of isotopes on the appearance of mass spectrum. EPR spectra of anisotropic systems - anisotropy in g- value, causes of anisotropy, anisotropy in hyperfine coupling, hyperfine splitting caused by quadrupole nuclei. Zero-field splitting (ZFS) and Kramer's degeneracy. Applications of EPR to organic and inorganic systems. Structural elucidation of organic compounds by combined spectral techniques. Principle of Mossbauer spectroscopy: Doppler shift, recoil energy. Isomer shift, quadrupole splitting, magnetic interactions. Applications: Mossbauer spectra of high and low-spin Fe and Sn compounds.	**12**

Course Outcomes	
Course Outcomes	On completion of this course, students will;
CO1	To understand the importance of rotational and Raman spectroscopy.
CO2	To apply the vibrational spectroscopic techniques to diatomic and polyatomic molecules.
CO3	To evaluate different electronic spectra of simple molecules using electronic spectroscopy.
CO4	To outline the NMR, ^{13}C NMR, 2D NMR – COSY, NOESY, Introduction to ^{31}P, ^{19}FNMR and ESR spectroscopic techniques.
CO5	To develop the knowledge on principle, instrumentation and structural elucidation of simple molecules using Mass Spectrometry, EPR and Mossbauer Spectroscopy techniques.

Text Books (Latest Editions)	
1.	C. N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*, 4th Ed., Tata McGraw Hill, New Delhi, 2000.
2.	R. M. Silverstein and F. X. Webster, *Spectroscopic Identification of Organic Compounds*, 6th Ed., John Wiley & Sons, New York, 2003.

3. W. Kemp, *Applications of Spectroscopy*, English Language Book Society, 1987.

4. D. H. Williams and I. Fleming, *Spectroscopic Methods in Organic Chemistry*, 4th Ed., Tata McGraw-Hill Publishing Company, New Delhi, 1988.
5. R. S. Drago, *Physical Methods in Chemistry*; Saunders: Philadelphia, 1992.

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1. P.W. Atkins and J. de Paula, *Physical Chemistry*, 7th Ed., Oxford University Press, Oxford, 2002.
2. I. N. Levine, *Molecular Spectroscopy*, John Wiley & Sons, New York, 1974.
3. A. Rahman, *Nuclear Magnetic Resonance-Basic Principles*, Springer-Verlag, New York,1986.
4. K. Nakamoto, *Infrared and Raman Spectra of Inorganic and coordination Compounds*, PartB: 5th ed., John Wiley& Sons Inc., New York, 1997.
5. J. A. Weil, J. R. Bolton and J. E. Wertz, *Electron Paramagnetic Resonance*; Wiley Interscience, 1994.

Web Resources

1. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
2. https://www.digimat.in/nptel/courses/video/104106122/L14.html

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		**RESEARCH TOOLS AND TECHNIQUES IN CHEMISTRY**						
Category	AECC - 3	**Year**	II	**Credits**	2	**Course Code**	**232204308**	
		Semester	III					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		2	--	--	2	25	75	100

Learning Objectives

- ✍ To understand the basic concepts in research methodology in chemical science.
- ✍ To develop the knowledge of report writing and framing Research proposals.
- ✍ To gain the knowledge of about collecting and processing various data types.
- ✍ To understand the concept of separation and purification techniques in chemical compounds.
- ✍ To discuss different types of characterization techniques and their uses.

UNIT	**Details**	
I	**Research Basics**: Basics of scientific research, research process and steps involved, Hypothesis, Research proposals and aspects, literature survey, sources of information, review. Ethical issues and intellectual property rights	**6**
II	**Scientific Report Writing and Publication Process**: Writing of research report and synopsis (steps involved), paper writing (steps involved), review writing, report preparation, publication process, selection of journals, citation index, impact factor, h-index	**6**
III	**Data Collection and Processing Data types and collection:** qualitative and quantitative, data processing, data analysis. Sampling: types, steps involved in sampling, sample size, advantages and limitations.	**6**
IV	**Analytical tool and Techniques:** Separation and purification techniques: Crystallization, distillation techniques (simple distillation, steam distillation, fractional distillation). Solvent extraction. Chromatography: Principles and applications of Thin layer chromatography, Column chromatography, Gas chromatography.	**6**
V	**Material characterization and Analysis:** Basic principles and applications of SEM, TEM, AFM and HPLC.	**6**

Course Outcomes	
Course Outcomes	On completion of this course, students will be able;
CO1	To understand and comprehend the basics in research methodology and applying them in research/ project work.
CO2	To gain the knowledge of scientific research writing and publication process.
CO3	To develop your knowledge and skills to lead, coordinate, and support data collection, processing and sample analysis.
CO4	To acquire knowledge on the qualitative analysis of separation of binary mixture of chemical compounds and purification techniques.
CO5	To know the basic principles and applications of different physicochemical techniques.

Text Books (Latest Editions)
1. Kumar, R., Research Methodology - A Step-By-Step Guide for Beginners, Pearson Education, Delhi (2006).
2. Montgomery, D. C., Design & Analysis of Experiments, 5th Ed., Wiley India (2007).
3. Kothari, C. K., Research Methodology-Methods and Techniques, 2nd Ed., New Age International, New Delhi.
4. Skoog D. A.,and West D.M., Principles of Instrumental Analysis, East West Press, New Delhi.
5. Willard H., Merit and Dean J. A., Instrumental Methods of Analysis, East west press, New Delhi.
Reference Books
1. Gurdeep Chatwal, S.K. Anand, Instrumental methods of Chemical analysis, Nirmalaya publication 2013.
2. Drago, R. S., Physical Methods for Chemists, Saunders Company (1999).
3. Aruldas, G., Molecular Structure and Spectroscopy, 2nd Ed., Prentice Hall India (2001).
4. Igwenagu C. Fundamentals of research methodology and data collection. LAP Lambert Academic Publishing; 2016.
5. Kothari CR. Research methodology: Methods and techniques. New Age International; 2004.
Web Resources
https://ccsuniversity.ac.in/bridgelibrary/pdf/MPhil%20Stats%20Research%20Methodology-Part1.pdf
https://mrcet.com/downloads/digital_notes/CSE/Mtech/I%20Year/RESEARCH%20METHODLOGY.pdf
http://shvaiko.ru/wp-content/uploads/2010/02/Analytical-Techniques-Julia-C.-Drees-Alan-H.-B.-Wu.pdf
https://secwww.jhuapl.edu/techdigest/content/techdigest/pdf/V06-N03/06-03-Charles.pdf

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Core Subject INTERNSHIP / INDUSTRIAL ACTIVITY Code: 232204309

SEMESTER III

Credit 2

Preamble:

- ***To give Exposure to real world experience.***

The Students will undergo minimum 7 days of summer internship/industrial activity training in subject related organization after their second semester for PG and Fourth semester for UG examinations (Summer Vacation).

The student will be allotted a faculty for guiding the internship/industrial activity. After the completion of the internship/industrial activity, he/she has to document the work, and submit the report along with the Certificate from the concern organization (2 copies – one to the Controller's Office, one to the Department Library)

The External viva voce examination will be conducted on or before last working day of the Third semester for PG and Fifth semester for UG.

Evaluation of internship/industrial activity

	Internal	External	Total
Internship Report	15	50	65
Viva	10	25	35
Total	25	75	100

Title of the Course		**COORDINATION CHEMISTRY – II**						
Category	Core - 10	**Year**	II	**Credits**	4	**Course Code**	**232204401**	
		Semester	IV					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		5	-	--	5	25	75	100

Learning Objectives

- ✍ To recognize the fundamental concepts and structural aspects of organometallic compounds.
- ✍ To learn reactions of organometallic compounds and their catalytic behaviour.
- ✍ To identify or predict the structure of coordination compounds using spectroscopic tools.
- ✍ To understand the structure and bonding in coordination complexes.
- ✍ To evaluate the spectral characteristics of selected complexes.

UNIT	**Details**	**No. of Periods for the Unit**
I	**Chemistry of organometallic compounds:** Classification of organometallic compounds based on M-C bond – 18 and 16 electron rule; Bonding in metal – olefin complexes (example: Ziese's salt), metal-acetylene and metal-allyl complexes; Metal-cyclopentadienyl complexes – Examples and MO approach to bonding in metallocenes; fluxional isomerism. Metal – carbonyl complexes: MO diagram of CO; Structure and bonding − bonding modes, MO approach of M-CO bonding, π-acceptor nature of carbonyl group, synergistic effect (stabilization of lower oxidation states of metals); Carbonyl clusters: Low nuclearity and high nuclearity carbonyl clusters – Structures based on polyhedral skeleton electron pair theory or Wade's rule.	**15**
II	**Reactions and catalysis of organometallic compounds:** Reactions of organometallic compounds: Oxidative addition, reductive elimination (α and β eliminations), migratory insertion reaction and metathesis reaction. Organo-metallic catalysis: Hydrogenation of olefins (Wilkinson's catalyst), hydroformylation of olefins using cobalt or rhodium catalysts (oxo process), oxidation of olefin (Wacker process), olefin isomerisation, water gas shift reaction, cyclo-oligomerisation of acetylenes using Reppe's catalysts, Monsonto process.	**15**
III	**Inorganic spectroscopy -I:** IR spectroscopy: Effect of coordination on the stretching frequency-sulphato, carbonato, sulphito, aqua, nitro, thiocyanato, cyano, thiourea, DMSO complexes; IR spectroscopy of carbonyl compounds. NMR spectroscopy- Introduction, applications of 1H, 15N, 19F, 31P-NMR spectroscopy in structural identification of inorganic complexes, fluxional molecules, quadrupolar nuclei- effect in NMR spectroscopy.	**15**
IV	**Inorganic spectroscopy-II:** Introductory terminologies: g and A parameters-definition, explanation and factors affecting g and A; Applications of ESR to coordination compounds with one and more than one unpaired electrons – hyperfine and secondary hyperfine splitting and Kramer's doublets; ESR spectra of V(II), Mn(II), Fe(II), Co(II), Ni(II), Cu(II) complexes, bis(salicylaldimine)copper(II) and $[(NH_3)_5Co\text{-}O_2\text{-}Co(NH_3)_5]^{5+}$. Mossbauer spectroscopy – Mossbauer effect, Recoil energy, Mossbauer active nuclei, Doppler shift, Isomer shift, quadrupole splitting and magnetic interactions. Applications of Mössbauer spectra to Fe and Sn compounds.	**15**

V	**Photo Electron Spectroscopy:** Theory, Types, origin of fine structures - shapes of vibrational fine structures – adiabatic and vertical transitions, PES of homonuclear diatomic molecules (N_2, O_2) and heteronuclear diatomic molecules (CO, HCl) and polyatomic molecules (H_2O, CO_2, CH_4, NH_3) – evaluation of vibrational constants of the above molecules. Koopman's theorem- applications and limitations. Optical Rotatory Dispersion – Principle of CD and ORD; Δ and λ isomers in complexes, Assignment of absolute configuration using CD and ORD techniques.	**15**

Course Outcomes	
Course Outcomes	On completion of this course, students will be able;
CO1	Understand and apply 18 and 16 electron rule for organometallic compounds
CO2	Understand the structure and bonding in olefin, allyl, cyclopentadienyl and carbonyl containing organometallic compounds
CO3	Understand the reactions of organometallic compounds and apply them in
CO4	understanding the catalytic cycles
CO5	Identify / predict the structure of coordination complexes using spectroscopic tools such as IR, NMR, ESR, Mossbauer and optical rotatory dispersion studies to interpret the structure of molecules by various spectral techniques.
Text Books (Latest Editions)	
1	J E Huheey, EA Keiter, RL Keiter and OK Medhi, Inorganic Chemistry – Principles of structure and reactivity, 4th Edition, Pearson Education Inc., 2006
2	G L Meissler and D ATarr, Inorganic Chemistry, 3rd Edition, Pearson Education Inc., 2008
3	D. Bannerjea, Co-ordination Chemistry, TATA Mcgraw Hill, 1993.
4	B D Gupta and A K Elias, Basic Organometallic Chemistry: Concepts, Syntheses and Applications, University Press, 2013.
5	F. A. Cotton, G. Wilkinson.; C. A. Murillo; M. Bochmann, Advanced Inorganic Chemistry, 6th ed.; Wiley Inter-science: New York, 1988.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals. 3rd ed. New York, NY: John Wiley, 2000.
2	P Gütlich, E Bill, A X Trautwein, Mossbauer Spectroscopy and Transition Metal Chemistry: Fundamentals and Applications, 1st edition, Springer-Verlag Berlin Heidelberg, 2011.
3	Concepts and Models of Inorganic Chemistry,B. Douglas, D. McDaniel, J. Alexander, John Wiley, 1994, 3rd edn.
4	K. F. Purcell, J. C. Kotz, Inorganic Chemistry; Saunders: Philadelphia, 1976.
5	R. S. Drago, PhysicaI Methods in Chemistry; Saunders: Philadelphia, 1977.
Web Resources	
1. https://archive.nptel.ac.in/courses/104/101/104101100/	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		**PHYSICAL CHEMISTRY-II**						
Category	Core - 11	**Year**	II	**Credits**	4	**Course Code**	**232204402**	
		Semester	IV					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		4	1	--	5	25	75	100

Learning Objectives

- ✍ To understand the essential characteristics of wave functions and need for the quantum mechanics.
- ✍ To know the importance of quantum mechanical models of particle in a box, rigid rotor and harmonic oscillator.
- ✍ To apply the quantum mechanics to hydrogen and polyelectronic systems
- ✍ To familiarize the symmetry in molecules and predict the point groups.
- ✍ To predict the vibrational modes, hybridization using he concepts of group theory.

UNIT	**Details**	**No. of Periods for the Unit**
I	**Introduction of Quantum Mechanics**: Wave particle duality, Uncertainty principle, Particle wave and Schrodinger wave equation, wave function, properties of wave function. Properties of wave function, Normalized, Orthogonal, orthonormal, Eigen values, Eigen functions, Hermitian properties of operators. Introduction to quantum mechanics-black body radiation, photoelectric effect, hydrogen spectrum. Need for quantum mechanics, Postulates of Quantum Mechanics, Schrodinger wave equation, Time independent and time dependent	**15**
II	**Quantum models:** Particle in a box-1D, two dimensional and three-dimensional, degeneracy, application to linear conjugated molecular system, free particles, ring systems. Harmonic Oscillator-wave equation and solution, anharmonicity, force constant and its significance. Rigid Rotor-wave equation and solution, calculation of rotational constants and bond length of diatomic molecules.	**15**
III	**Applications to Hydrogen and Poly electron atoms:** Hydrogen atom and hydrogen like ions, Hamiltonian-wave equation and solutions, radial and angular functions, representation of radial distribution functions. Approximation methods –variation methods: trial wave function, variation integral and application to particle in 1D box. Perturbation method - first order applications. Hatrefock self-consistent field method, Hohenberg-Kohn theorem and Kohn-Sham equation, Helium atom-electron spin, paulis exclusion principle and Slater determination.	**15**
IV	**Group theory:** Groups, sub groups, symmetry elements, operations, classification-axial and non-axial. Dihedral point groups- C_n, C_{nh}, D_n, D_{nh}, D_{nd}, Td and Oh. Matrix representation and classes of symmetry operations, reducible irreducible and direct product representation. The Great orthogonality theorem – irreducible representation and reduction formula, construction of character table for C_{2v}, C_{2h}, C_{3v} and D_{2h} point groups.	**15**
V	**Applications of quantum and group theory:** Hydrogen Molecule-Molecular orbital theory and Heitler London (VB) treatment, Energy level diagram, Hydrogen molecule ion; Use of linear variation function and LCAO methods. Electronic conjugated system: Huckel method to Ethylene butadiene, cyclopropenyl, cyclo butadiene and Benzene. Applications of group theory to molecular vibrations, electronic spectra of ethylene.	**15**

Course Outcomes	
Course Outcomes	On completion of this course, students will be able
CO1	To discuss the characteristics of wave functions and symmetry functions.
CO2	To classify the symmetry operation and wave equations.
CO3	To apply the concept of quantum mechanics and group theory to predict the electronic structure.
CO4	To specify the appropriate irreducible representations for theoretical applications.
CO5	To develop skills in evaluating the energies of molecular spectra.

Text Books (Latest Editions)	
1	R.K. Prasad, Quantum Chemistry, New Age International Publishers, New Delhi, 2010, 4th revised edition.
2	F. A. Cotton, Chemical Applications of Group Theory, John Wiley & Sons, 2003, 2nd edition.
3	A. Vincent, Molecular Symmetry and Group Theory. A Programmed Introduction to Chemical Applications, John and Willy & Sons Ltd., 2013, 2nd Edition.
4	T. Engel & Philip Reid, Quantum Chemistry and Spectroscopy, Pearson, New Delhi, 2018, 4th edition.
5	G. K. Vemulapalli, Physical Chemistry, Prentice Hall of India Pvt. Ltd. 2001. 6. D.A. McQuarrie, Quantum Chemistry, Viva Books PW. Ltd, 2013, 2nd edition.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1	N. Levine, Quantum Chemistry, Allyn& Bacon Inc, 1983, 4th edition.
2	D.A. McQuarrie and J. D. Simon, Physical Chemistry, A Molecular Approach, Viva Books Pvt. Ltd, New Delhi, 2012.
3	R. P. Rastogi & V. K. Srivastava, An Introduction to Quantum Mechanics of Chemical Systems, Oxford & IBH Publishing Co., New Delhi, 1999.
4	R.L. Flurry. Jr, Symmetry Group Theory and Chemical applications, Prentice Hall. Inc, 1980
5	J. M. Hollas, Symmetry in Molecules, Chapman and Hall, London, 2011, Reprint.
Web Resources	
1. https://nptel.ac.in/courses/104101124 2. https://ipc.iisc.ac.in/~kls/teaching.html	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15

Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		**ANALYTICAL INSTRUMENTATION TECHNIQUES PRACTICALS**					
Category	Core - 12	**Year**	II	**Credits**	4	**Course Code**	**232204403**
		Semester	IV				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
	-	-	5	5	25	75	100

Learning Objectives

- ✍ To design chromatographic methods for identification of species.
- ✍ To analyze different constituents through instrumental methods of analysis.
- ✍ To evaluate different contaminants in materials using turbidimetry and conductivity measurements.
- ✍ To design experiments for analysis of inorganic and organic materials.
- ✍ To analyze constituents in materials using emission and absorption techniques.

Experiment

1. Determination of the equivalent conductance of a weak acid at different concentrations and verifying Ostwald dilution law. Calculation of the dissociation constant of the acid.
2. Determination of the equivalent conductance of a strong electrolyte at different concentrations and examining the validity of the Onsager's theory as limiting law at high dilutions.
3. Conductometric titration of a mixture of HCl and CH_3COOH Vs NaOH.
4. Conductometric titration of NH_4Cl Vs NaOH.
5. Conductometric titration of CH_3COONa Vs HCl.
6. Potentiometric titration of a mixture of HCl and CH_3COOH Vs NaOH
7. Determination of pK_a of weak acid by EMF method.
8. Potentiometric titration of FAS Vs $K_2Cr_2O_7$
9. Potentiometric titration of KI Vs $KMnO_4$.
10. Potentiometric titration of a mixture of Chloride and Iodide Vs $AgNO_3$.
11. Determination of the pH of buffer solution by EMF method using Quinhydrone and Calomel electrode.

Study of the inversion of cane sugar in the presence of acid by Polarimetric method.

1. Estimation of Fe, Cu and Ni by colorimetric method.
2. Estimation of Na and K by flame photometric method.
3. Determination of spectrophotometrically the mole ratio of the ferrithiocyanate complex and equilibrium constant for the complex formation.
4. Determination of the amount (mol/L) of ferricyanide present in the given solution using cyclic voltammetry.
5. Determination of the diffusion coefficient of ferricyanide using cyclic voltammetry.
6. Determination of the standard redox potential of ferri-ferrocyanide redox couple using cyclic voltammetry.
7. Estimation of the amount of sulphate present in the given solution using Nephelometric turbidimeter.
8. Estimation of the amount of nitrate present in the given solution using spectrophotometric method.
9. Heavy metal analysis in textiles and textile dyes by AAS
10. Determination of caffeine in soft drinks by HPLC
11. Analysis of water quality through COD, DO, BOD measurements.
12. Assay of Riboflavin and Iron in tablet formulations by spectrophotometry
13. Estimation of chromium in steel sample by spectrophotometry
14. Determination of Stern-Volmer constant of Iodine quenching by fluorimetry
15. Determination of ascorbic acid in real samples using Differential Pulse Voltammetry and

comparing with specifications

16. Separation of (a) mixture of Azo dyes by TLC (b) mixture of metal ions by Paper chromatography
17. Estimation of chlorophyll in leaves and phosphate in waste water by colorimetry.
18. Estimation of Fe(II) by 1,10 phenonthroline using spectrophotometry

Course Outcomes	On completion of this course, students will;
CO1	To recall the principles associated with various inorganic organic and physical chemistry experiments
CO2	To scientifically plan and perform all the experiments
CO3	To observe and record systematically the readings in all the experiments
CO4	To calculate and process the experimentally measured values and compare with graphical data.
CO5	To interpret the experimental data scientifically to improve students efficiency for societal developments.

Text Books (Latest Editions)	
1	Vogel's Text book of Practical Organic Chemistry, 5th Ed, ELBS/Longman, England, 2003
2	G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, *Vogel's Textbook of Quantitative Chemical Analysis*; 6th ed., ELBS, 1989.
3	J. D. Woollins, *Inorganic Experiments*; VCH: Weinheim, 1995
4	B. Viswanathan and P.S.Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009.
5	Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S.Viswanathan Co. Pvt., 1996.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1	N. S. Gnanapragasam and G. Ramamurthy, Organic Chemistry – Labmanual, S. Viswanathan Co. Pvt. Ltd, 2009.
2	J. N. Gurtu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 2011.
3	J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
4	G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009.
5	J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Core PROJECT WITH VIVA VOCE Code: 212204404

SEMESTER IV 5 Hrs / Credits 3

Post Graduate students of Chemistry will do projects under the guidance of staff members of chemistry during IV semester. The projects will be on chemistry and chemistry related fields. The project diary signed by the project guide and HOD must be submitted in the month of April. The Viva on Project will be conducted jointly by the guide, external examiner and the HOD.

	Internal	External
Project	15	50
Viva	10	25

Title of the Course		**POLYMER CHEMISTRY**						
Category	EC – 6.1	**Year**	II	**Credits**	4	**Course Code**	**232204405**	
		Semester	III					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		4	-	--	4	25	75	100

Learning Objectives

- To learn the basic concepts and bonding in polymers.
- To explain various types of polymerization reactions and kinetics.
- To understand the importance of industrial polymers and their synthetic uses.
- To determine the molecular weight of polymers.
- To predict the degradation of polymers and conductivities.

UNIT	**Details**	**No. of Periods for the Unit**
I	**Characterization, Molecular weight and its Determination:** Primary and secondary bond forces in polymers; cohesive energy, molecular structure, chemical tests, thermal methods, Tg, molecular distribution, stability. Determination of Molecular mass of polymers: Number Average molecular mass (M_n) and Weight average molecular mass (M_w) of polymers. Molecular weight determination of high polymers by physical and methods.	**12**
II	**Mechanism and kinetics of Polymerization:** Chain growth polymerization: Cationic, anionic, free radical polymerization, Stereo regular polymers: Ziegler Natta polymerization. Reaction kinetics. Step growth polymerization, Degree of polymerization.	**12**
III	**Techniques of Polymerization and Polymer Degradation:** Bulk, Solution, Emulsion, Suspension, solid, interfacial and gas phase polymerization. Types of Polymer Degradation, Thermal degradation, mechanical degradation, photodegradation, Photo stabilizers, Solid and gas phase polymerization.	**12**
IV	**Industrial Polymers:** Preparation of fibre forming polymers, elastomeric material. Thermoplastics: Polyethylene, Polypropylene, polystyrene, Polyacrylonitrile, Poly Vinyl Chloride, Poly tetrafluoro ethylene, nylon and polyester. Thermosetting Plastics: Phenol formaldehyde and expoxide resin. Elastomers: Natural rubber and synthetic rubber - Buna - N, Buna-S and neoprene. Conducting Polymers: Elementary ideas; examples: poly sulphur nitriles, poly phenylene, poly pyrrole and poly acetylene. Polymethylmethacrylate, polyimides, polyamides, polyurethanes, polyureas, polyethylene and polypropylene glycols.	**12**
V	**Polymer Processing:** Compounding: Polymer Additives: Fillers, Plasticizers, antioxidants, thermal stabilizers, fire retardants and colourants. Processing Techniques: Calendaring, die casting, compression moulding, injection moulding, blow moulding and reinforcing. Film casting, Thermofoaming, Foaming. Catalysis and catalysts – Polymerization catalysis, catalyst support, clay compounds, basic catalyst, auto-exhaust catalysis, vanadium, heterogeneous catalysis and active centres.	**12**

Course Outcomes	
Course Outcomes	On completion of this course, students will be able
CO1	To understand the bonding in polymers.
CO2	To scientifically plan and perform the various polymerization reactions.
CO3	To observe and record the processing of polymers.
CO4	To calculate the molecular weight by physical and chemical methods.
CO5	To interpret the experimental data scientifically to improve the quality of synthetic polymers.
Text Books (Latest Editions)	
1	V.R. Gowariker, *Polymer Science*, Wiley Eastern, 1995.
2	G.S. Misra, *Introductory Polymer Chemistry*, New Age International (Pvt) Limited, 1996.
3	M.S. Bhatnagar, A Text Book of Polymers, vol-I & II, S.Chand & Company, New Delhi, 2004.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1	F. N. Billmeyer, *Textbook of Polymer Science*, Wiley Interscience, 1971.
2	A. Kumar and S. K. Gupta, *Fundamentals and Polymer Science and Engineering*, Tata McGraw-Hill, 1978.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		**CHEMINFORMATICS**						
Category	EC – 6.2	**Year**	II	**Credits**	4	**Course Code**	**232204406**	
		Semester	III					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		4	-	--	4	25	75	100

Learning Objectives

- ✍ ***To improve the knowledge of chemical structure representation and Chemoinformatics tools for drug discovery***
- ✍ ***This subject will help to understand the basic concept of chemoinformatics***

UNIT	**Details**	**No. of Periods for the Unit**
I	Computer Representation of Molecules in Databases: Molecular models – Chem draw – Connection table – Linear notation – Canonical representation – Substructure – Sub graph isomerism based finger print.	**12**
II	Chemical Information – An Introduction: History of Scientific Information – Periodic table – Homologous series – Concepts in Chemistry – Internet test servers – Molecular formats and MIME.	**12**
III	Computer Sources of Chemical Information: Communication – WWW – URLS – Chemistry on website – Chemical literature – Secondary literature.	**12**
IV	Chemical Information Searches: Searching skills – Strategies – Advantages and disadvantages – CAS – Keyword search – Chemical abstract – Flow of chemical information and computer searching.	**12**
V	Application of Cheminformatics: Chemical databases – 2D substructure searching – 3D database searching – Generation and retrieval – Use of QSAR and combinatorial library in drug design.	**12**

Course Outcomes

Course Outcomes	On completion of this course, students will be able
CO1	To understand the Molecular models
CO2	To scientifically plan and perform the various analysis of Chemical Information
CO3	To understand the Chemical literature.
CO4	To identify the chemical information and computer searching.
CO5	To interpret the experimental data scientifically to improve the quality of drug design.

Text Books (Latest Editions)

Handbook of Chemoinformatics, volume 1, by John Gastiger, Thomas Engel, WILEYVCH pub 2003.

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1	Andrew R.Leach, Molecular Modelling, Principles and Applications, 2nd Edition, Dorset Press, Dorchester, Dorset, 2001.
2	An Introduction to Chemoinformatics, by Andrew R. Leach & Valerie j. Gillet, Springer.
3	Instant Notes in Medicinal Chemistry, by G. Patrick, BIOS Scientific pub.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		**CHEMISTRY OF NATURAL PRODUCTS**						
		B						
Category	SEC 4	**Year**	II	**Credits**	2	**Course Code**	**232204407**	
		Semester	IV					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		4	--	--	4	25	75	100

Learning Objectives

- To learn the basic concepts and biological importance of biomolecules and natural products.
- To elucidate the structure determination of biomolecules and natural products.
- Explain the fundamentals of UV-Vis and IR spectroscopy.
- Make use of the basic principles underlying NMR and mass spectroscopy and its application in structural elucidation.

UNIT	**Details**	**No. of Periods for the Unit**
I	**Alkaloids and Terpenoids:** **a)** **Alkaloids:** Introduction, occurrence, classification, isolation and functions ofalkaloids. Classification, general methods of structurale lucidation. Chemical methods of structure determination of Quinine and Morphine. **Terpenoids:** Introduction, occurrence, Isoprene rule,classification. General methods of determiningstructure. Structure determination of Camphor, Abietic acid, Cadinene and Zingiberine.	**12**
II	**Anthocyanines, flavones, Purines and Steroids:** a) **Anthocyanines andflavones:** Introduction toanthocyanines. Structure and synthesis ofanthocyanines, Cyanidine chloride: structure and determination. Flavones: Structure and determination of Quercetin. **b) PurinesandSteroids:** Introduction, Cccurrence and isolation of purines. Classification and spectral properties of steroids. Structure and synthesis of Uric acid and Caffeine. Steroids: Diels' hydrocarbon, biological importance, colour reactions of sterols, cholesterol-occurrence, tests, physiological activity, biosynthesis of cholesterol from squalene.	**12**
III	**Spectroscopy:** a) **UV Spectroscopy** – introduction – electronic transition – Wood Ward rules – calculation of Xmax of Conjugated Dienes, αβ – Unsaturated Carbonyl Compounds and aromatic compounds – study of in cis – trans isomers – Tautomers –axial and equatorial α haloketones – charge transfer complexes.. **b) IR Spectroscopy** – finger print region Molecular Vibrations – Fermi resonance to over tones Vibrational Frequency – Factors Influencing Group Frequencies – study of hydrogen bonding.	**12**
IV	**Mass Spectroscopy:** Mass Spectroscopy: Principle, Type of ions, Base Peak, Parent ion, Metastable ion and Isotopic ions Nitrogen rule, Fragmentation, General Rules, Pattern of Fragmentation for Various classes of Compounds, McLafferety Rearrangement – Retro Diels – Alder Reaction.	**12**

V	**NMR Spectroscopy:** a) ^{1}H – NMR Origin of NMR Spectra, Chemical Shift. Spin – Spin Coupling, Coupling Constant, First Order and Second Order Spin – Spin Splitting, Influence of Stereochemical Factors on Chemical Shift of Protons, Simplification of Complex Spectra, Spin Decoupling – Double Resonance, Shift Reagents, CIDNP. b) ^{13}C – NMR Spectroscopy, Basic Principle of FT Technique, Assignment of the Signals – broad band decoupling Off, Resonance Decoupling **c)** 2D NMR techniques– COSY, HETCOR, NOESY, INADEQUATE. Structural Problems based on all the above Techniques.	**12**

Course Outcomes	
Course Outcomes	On completion of this course, students will be able;
CO1	To understand the biological importance of chemistry of natural products.
CO2	To scientifically plan and perform the isolation and characterization of synthesized natural products.
CO3	To explain the fundamental concepts of UV-Vis and IR spectroscopy and analyze their application in simple molecules
CO4	To understand the basic concept of mass spectroscopy.
CO5	To explain the theories of NMR spectroscopy of organic molecule.

Text Books (Latest Editions)
1. G. K. Chatwal, Organic Chemistry on Natural Products, Vol. 1, Himalaya Publishing House, Mumbai, 2009. 2. G. K. Chatwal, Organic Chemistry on Natural Products, Vol. 2, Himalaya Publishing House, Mumbai,2009. 3. Dyer J.R., Application of Absorption Spectroscopy, 2nd Edition, Prentice–Hall, Hampshire, 1965. 4. Howe I., Williams D.H. and Bowen R.D., Mass Spectrometry, Principles and Applications McGraw Hill, 2nd Edition, New Delhi, 1981. 5. Kemp, Organic Spectroscopy, ELBS, 3rd Edition, Hampshire, UK, 1987.
References Books **(Latest editions, and the style as given below must be strictly adhered to)**
1. L. Finar, Organic Chemistry Vol-2, 5thedition,PearsonEducation Asia, 1975.
2. L. Finar, Organic Chemistry Vol-1, 6thedition, Pearson Education Asia,2004.
3. Silverstein B.M., Bassler G.C., and Morrill T.C., Spectrometric Identification of Organic Compounds. Wiley, 5thEditionn., New York, 1963.
4. Morrison R.T., and Boyd R.N., Organic Chemistry, Prentice–Hall, 6th Edition, New Delhi, 1995.
Web Resources
1. https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5
CO1	**S**	**S**	**S**	**M**	**S**
CO2	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**M**	**M**	**S**
CO4	**S**	**M**	**M**	**M**	**S**
CO5	**S**	**M**	**M**	**M**	**S**

3 – Strong, 2 – Medium , 1 - Low

Mapping with Programme Specific Outcomes:

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		**INTERPRETATION AND IDENTIFICATION OF CHEMICAL COMPOUNDS**						
Category	AECC 4	**Year**	II	**Credits**	2	**Course Code**	**232204408**	
		Semester	IV					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		-	--	2	2	25	75	100
Prerequisites		**Basic knowledge of chemistry**						

Learning Objectives

- To analyze constituents in the material using emission and absorption techniques.

Experiment

Interpretation and identification of the given spectra of various chemical compounds arrived at the following instruments

1.UV-Visible
2. IR
3.Raman
4. Mass
5.ESR
6. NMR

Course Outcomes	
Course Outcomes	On completion of this course, students will be able;
CO1	To interpret the experimental data scientifically to improve the students efficiency for social developments.

Text Books (Latest Editions)

1. Robert silverstein & Francis webster , spectrometric identification of organic compounds, 6th ed, john wiley & sons, 2006.
2. Hamming M, editor. Interpretation of mass spectra of organic compounds. Elsevier; 2012 Dec 2.
3. Jacobsen NE. NMR data interpretation explained: understanding 1D and 2D NMR spectra of organic compounds and natural products. John Wiley & Sons; 2016 Oct 31.
4. Mabbs FE, Collison D. Electron paramagnetic resonance of d transition metal compounds. Elsevier; 2013 Oct 22.
5. Larkin P. Infrared and Raman spectroscopy: principles and spectral interpretation. Elsevier; 2017 Nov 13.

Web Resources

1. https://www.wiley.com/en-us/Interpretation+of+Organic+Spectra-p-9780470825167
2. https://search.worldcat.org/title/Interpreting-spectra-of-organic-molecules/oclc/19639258

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1		S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S
CO5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium , 1 – Low

EXTENSION ACTIVITY

Course Code: 232204409

Credit: 1

The Students should undergo any of the following activities during the period of the program (Two Years) outside the college or in any other institutions. This Extension Activity will be evaluated through the certificate (minimum one) submitted by the students. As per the norms, students must carry out any one of the activity for obtaining the PG Degree. The concern Head of the Department will evaluate the students and submit the report to the Controller of Examinations at the end of the IV semester.

List of Extension Activity:

a) Conducting rally, awareness program etc.

b) Seed ball, tree plantation, cleaning work etc.

c) Blood donation, medical camp, organ donation etc.

d) Assisting school children, tribals, and illiterate in learning.

e) Giving assistance to orphanages and old age homes and patients.

f) Awareness program on financial literacy, gender equality, women education etc.

Any other activities which are relevant to develop nearby localities.